Joint Modeling and Simulation System (JMASS)

Tip of the DoD Modeling and Simulation (M&S) Iceberg?

Briefer: Bob Meyer, JMASS
                    Navy Senior Engi

Date: 10 September 2002

Joint Modeling and Simulation System (JMASS)

Composable Simulations before Composability was Cool…!

Briefer: Bob Meyer, JMAS
  Navy Senior Engi
Date: 10 September 2002

Purpose of this Presentation

Review "truths" and implications of the JMASS "paradigm shift."

Discuss what these implications mean and how this colors the actual benefit of (potentially) all M&S to the DoD community.

Highlight the common dependence of all DoD combat-related M&S on the existence and maintenance of a stable, consistent, well-managed set of system and phenomena models.

Argue that simulation composability is application dependent (i.e., detail, accuracy, fidelity, resolution, aggregation, etc.).

Conclude that JMASS composability is in fact representative of all DoD M&S composability and thus JMASS could be considered as the tip of the DoD M&S iceberg!
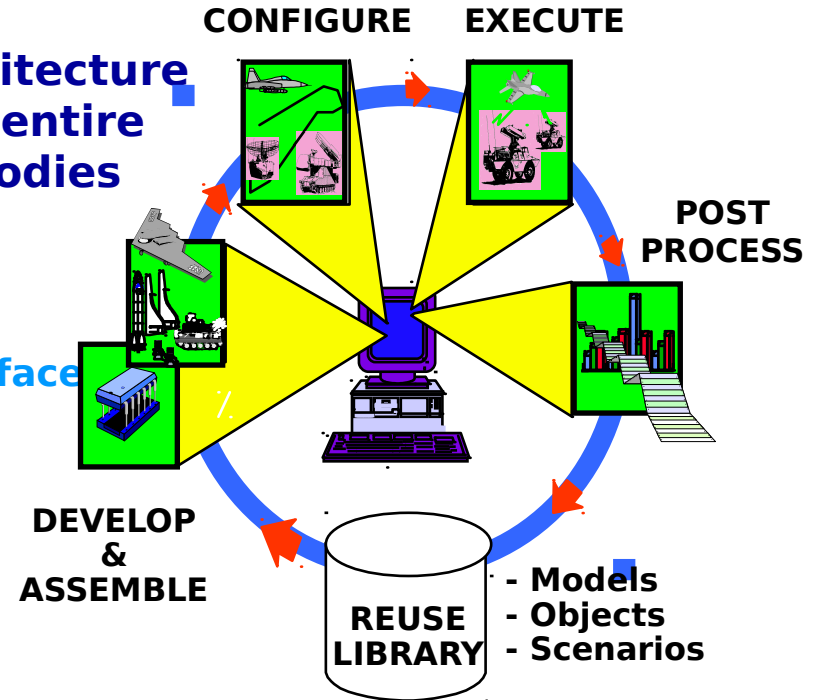
Joint Modeling and Simulation System

JMASS is a systems-level software architecture that supports M&S analysis across the entire acquisition cycle - in short, JMASS embodies the SBA concept

- **Model Standards**
  - **Software Structural Model for Reuse**
  - **Model Application Programming Interface**

- **Simulation Support Environment**
  - **Simulation Engine**
  - **Model Development Tools**
  - **Analysis Tools**
  - **COTS & Legacy Tool Interface**

- **Model Library & Repository**
  - **Local Model and Data Library**
  - **Modeling and Simulation Resource Repository**

CONFIGURE   EXECUTE

POST PROCESS

DEVELOP & ASSEMBLE

REUSE LIBRARY

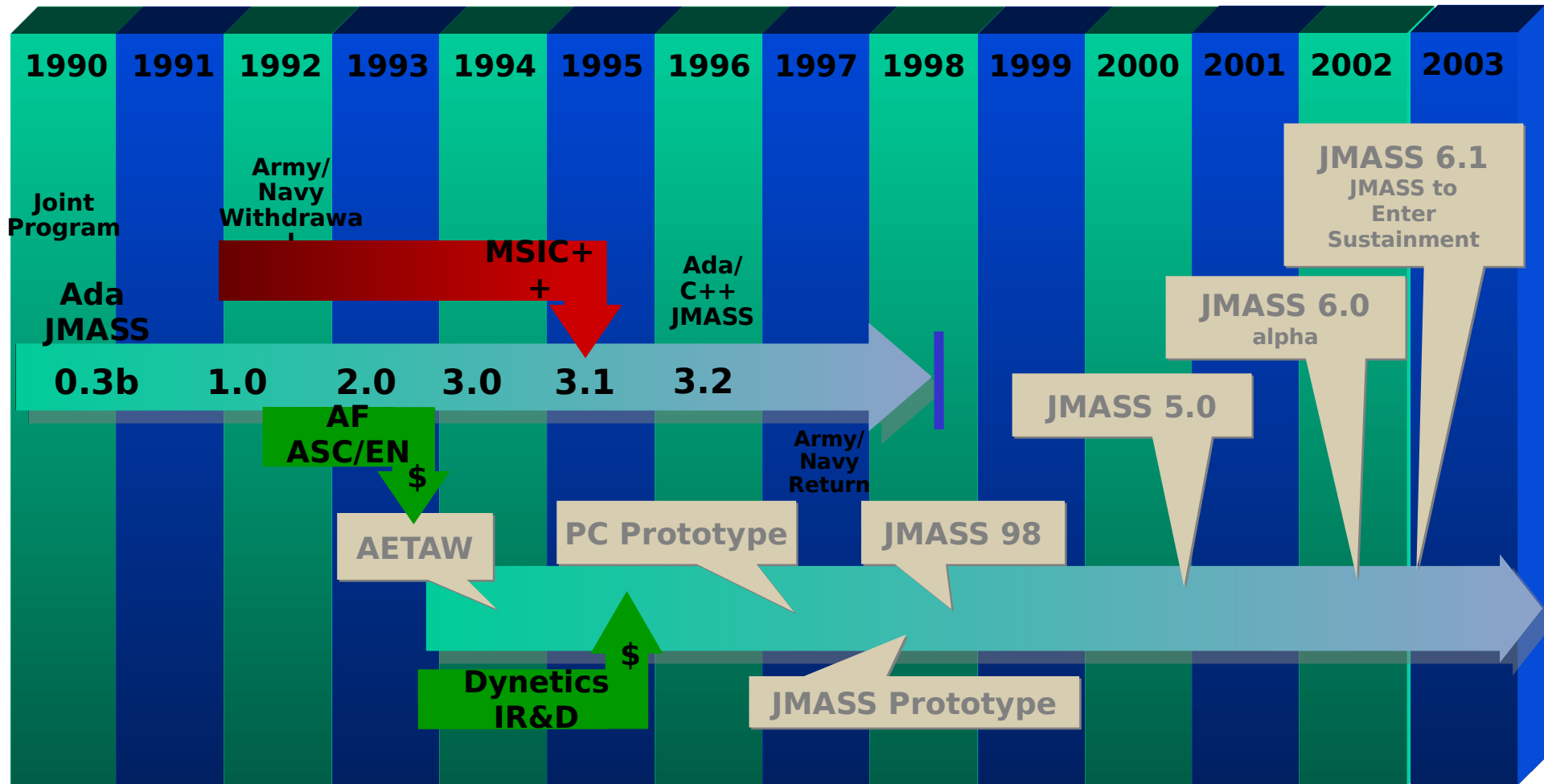**- Models**
- Objects
- Scenarios

The ability to reuse and interchange high-fidelity, physics-based models is perhaps the most visible and important of the many benefits of JMASS

The JMASS customer base continues to expand and includes a wide variety of applications supporting acquisition, T&E and operational activities
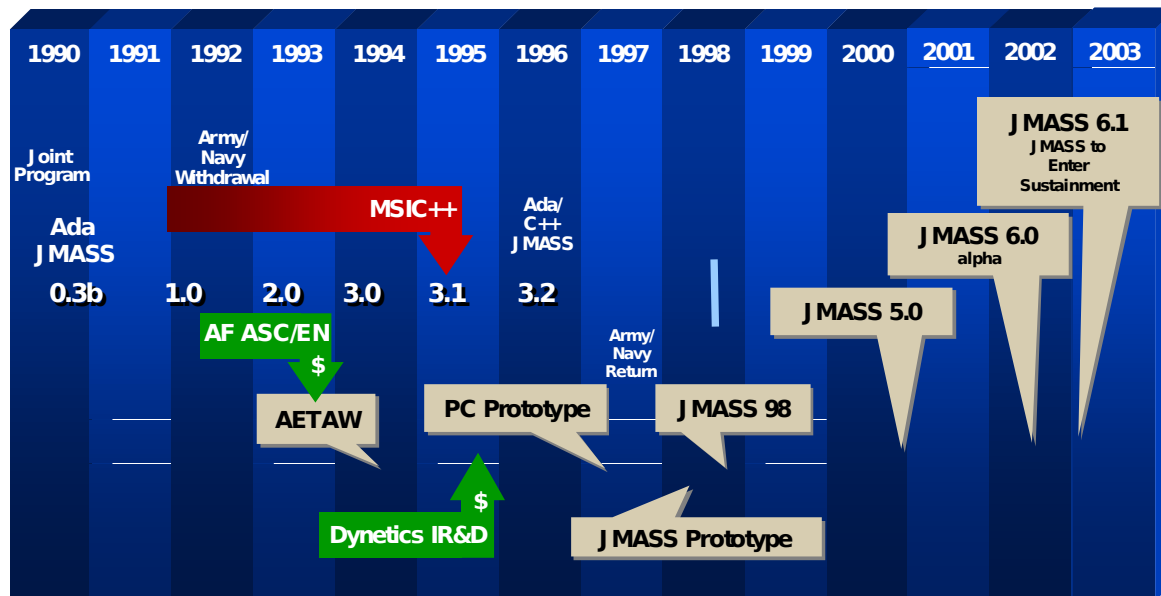
JMASS History

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003

Joint Program

Army/Navy Withdrawal

Ada JMASS

MSIC++

Ada/C++ JMASS

JMASS 6.1
JMASS to Enter Sustainment

JMASS 6.0
alpha

0.3b   1.0   2.0   3.0   3.1   3.2

JMASS 5.0

AF ASC/EN

$

Army/Navy Return

AETAW

PC Prototype

JMASS 98

Dynetics IR&D

$

JMASS Prototype

Where We Are: JMASS 5.x

- **JMASS v5.2 released in February 2002**
  - **Complete redesign of services to support pluggability**
  - **Synchronous communications support**
  - **HLA capability**
  - **Help system**
  - **Multithreading support**

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003

Joint Program

Army/Navy Withdrawal

MSIC++

Ada/C++ JMASS

Ada JMASS

0.3b   1.0   2.0   3.0   3.1   3.2

JMASS 6.1
JMASS to Enter Sustainment

JMASS 6.0
alpha

JMASS 5.0

AF ASC/EN
$

Army/Navy Return

AETAW

PC Prototype

JMASS 98

$

Dynetics IR&D

JMASS Prototype

Where We Are Headed: JMASS 6.x

- **Primary New Features**
  - File formats converted to industry standard XML and XMI
  - All new configuration tool
  - Graphical CDF editor (model design and development tool)
  - SEDRIS support
  - Automated installation
- **JMASS v6.0 Alpha released 14 Jun 02**
- **JMASS v6.1 Beta due for release 16 Sep 02**
- **JMASS v6.1 Final scheduled for Jan 03 release**
  - JMASS is scheduled to enter sustainment in February 2003, having met over 90% of its JORD requirements 1 year ahead of schedule and $5M (~20%) under budget
- **Sustainment is planned to be jointly funded and managed, under ESC oversight and DAC control**
  - JPO is scheduled to close in March 2003…!?!?!

"Truths of JMASS"

- **JMASS is NOT a simulation**

- **All JMASS action is player-based**

- **JMASS is interface ignorant**

- **Compliant is NOT interoperable**
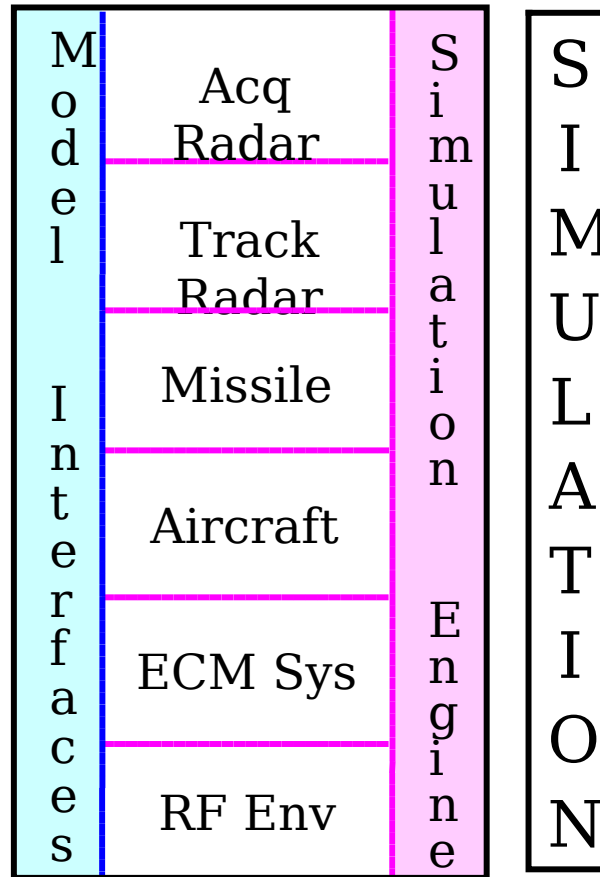
- **JMASS is NOT "plug and play"**

Views/aspects of a (SAM) simulation

JMASS

- Modular code
- Object-based style
- OO language
- Balanced fidelity
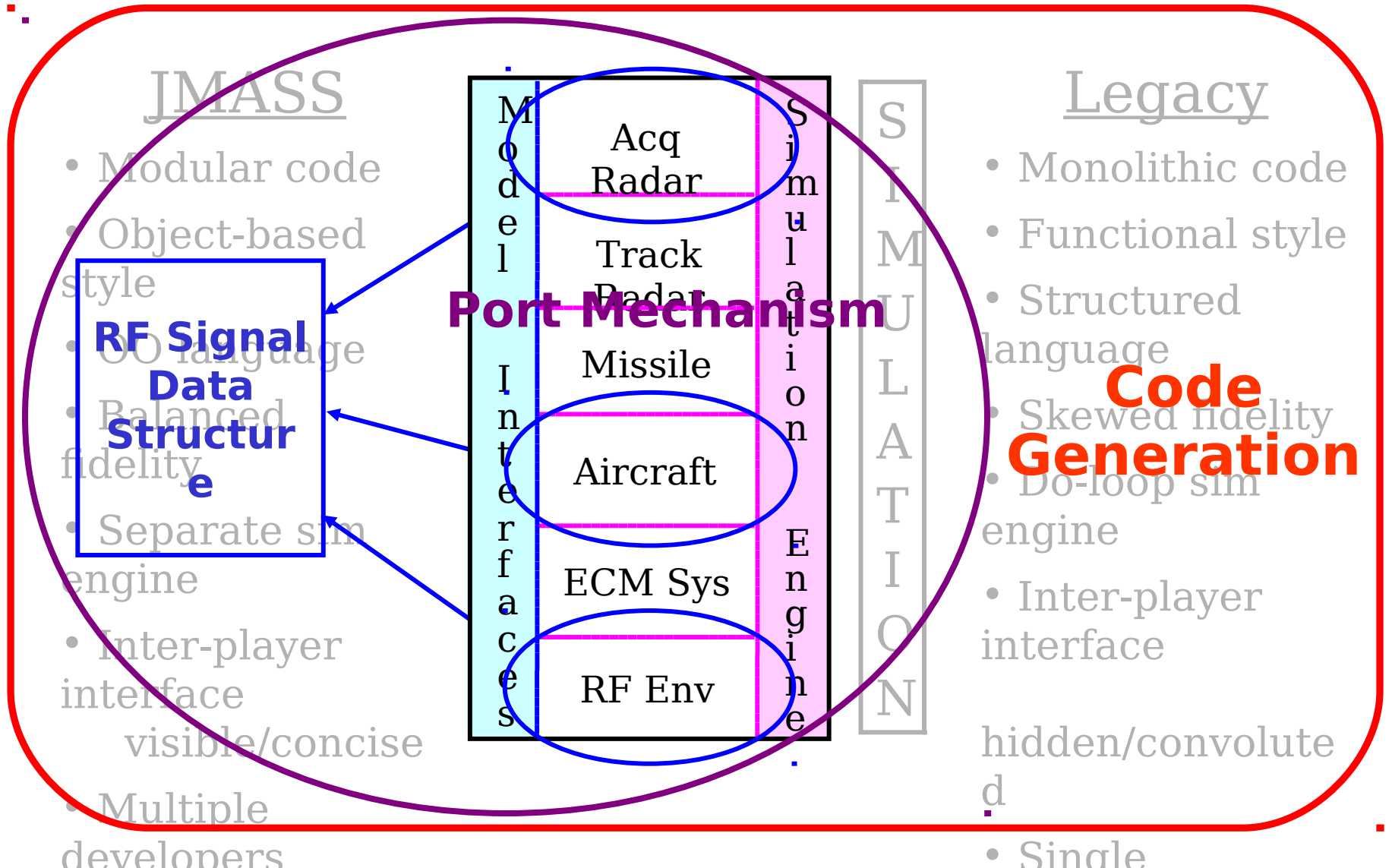- Separate sim engine
- Inter-player interface visible/concise
- Multiple developers

Model		Simulation
	Acq Radar	
	Track Radar	
Interfaces	Missile	Engine
	Aircraft	
	ECM Sys	
	RF Env	

SIMULATION

Legacy

- Monolithic code
- Functional style
- Structured language
- Skewed fidelity
- Do-loop sim engine
- Inter-player interface hidden/convoluted
- Single

Views/aspects of a (SAM) simulation

JMASS

- Modular code
- Object-based style
- OO language
- Balanced fidelity
- Separate sim engine
- Inter-player interface visible/concise
- Multiple developers

Legacy

- Monolithic code
- Functional style
- Structured language
- Skewed fidelity
- Do-loop sim engine
- Inter-player interface hidden/convoluted
- Single

Model Interfaces

Acq Radar

Track Radar

Missile

Aircraft

ECM Sys

RF Env

Simulation Engine

SIMULATION

RF Signal Data Structure

Port Mechanism

Code Generation

Matrix view of the JMASS system

Analysis Applications	Development Classes								
	Architecture		System Models		Env Models		Acft	Radar	Msl
	Stds	GUIs	ECM	Gun	RF	EO/IR			
Surface-to-air	X	X	X	X	X	X	X	X	X
Air-to-air	X	X	X	X	X	X	X	X	X
Sensor detection	X	X	X	X	X	X		X	
Air-to-surface	X	X	X	X	X		X	X	X
Surface-to-surface	X	X	X	X		X	X	X	X
Accreditation	← Verification and Validation →								

Implications of JMASS paradigm

- **JMASS is (supports/needs) distributed development**
  - Threat models from DIA, blue models from SPOs, etc.
  - Orthogonal view gives user and developer perspectives

- **JMASS is (promotes/defines) simulation integration**
  - Simulation integration begins with problem decomposition
  - Application functionality + player list = model requirements

- **JMASS is (enables/benefits from) software reuse**
  - Software reuse in M&S can/does occur at all levels
    - Debate rages over optimum level of software reuse
  - JMASS reuse currently focused at the player level

Block II RF SAM Simulation (digital)

JMASS

RF SAM Threat

style

AirCAT Model

• Balanced

GenECM Model

engine

JMOOSE 6.1

visible/concise

• Multiple
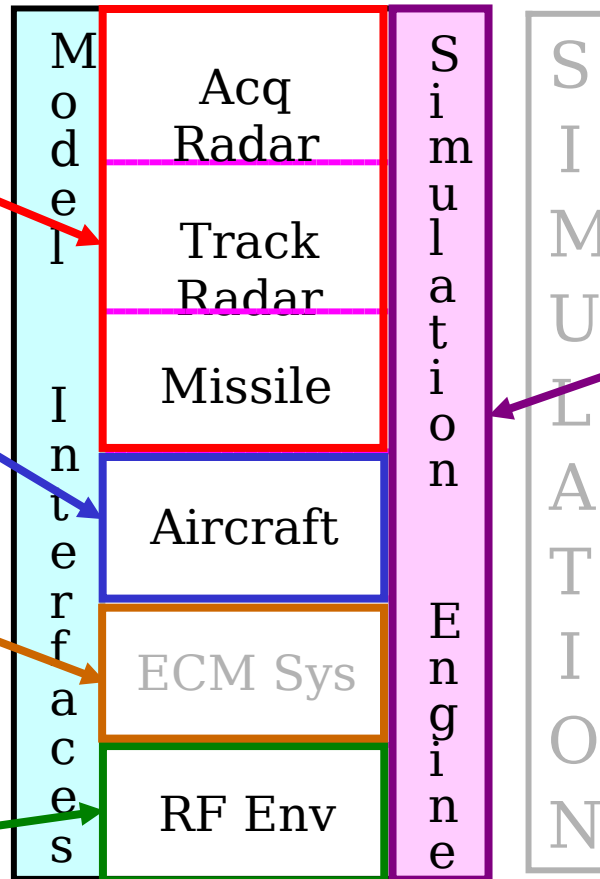
Model Interfaces

Acq Radar

Track Radar

Missile

Aircraft

ECM Sys

RF Env

Simulation Engine

SIMULATION

Legacy

• Monolithic code

• Functional style

JMASS 6.1

• Skewed fidelity

• Do-loop sim engine

• Inter-player interface

hidden/convoluted

• Single

RF SAM Simulation (OAR "hybrid")

JMASS

Hardware Proxy

style

DIA Threat Model

• Balanced

Aircraft Proxy

engine

• Inter-player interface
  visible/concise
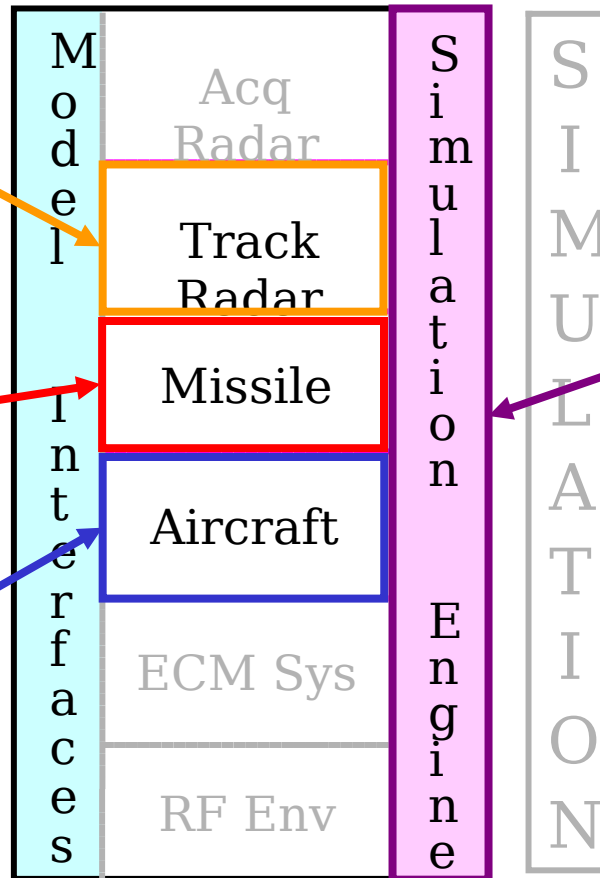
• Multiple

Model Interfaces

Acq Radar

Track Radar

Missile

Aircraft

ECM Sys

RF Env

Simulation Engine

SIMULATION

Legacy

• Monolithic code

• Functional style

JMASS 6.1

• Skewed fidelity

• Do-loop sim engine

• Inter-player interface

hidden/convoluted

• Single

Components of SBA Approach

- JMASS is (supports/needs) distributed development

Collaborative Environments

- JMASS is (promotes/defines) simulation integration
  - Simulation integration begins with problem decomposition

Data Interchange Formats

- JMASS is (enables/benefits from) software reuse
  - Software reuse in M&S can/does occur at all levels
    - Debate rages over optimum level of software reuse

Distributed Product Descriptions

Wait a minute...!?!?!

- **Sounds suspiciously like the newest term de jour!**
  - **Composability of Modeling and Simulation**
  - **Based on Component-Based Software Engineering (CBSE)**

- **Object-oriented was the previous M&S "magic phrase"**
  - **Spawned from the orgasmic embrace of OO ideas/practices by the computer science/programming communities**

- **Composing simulations from components**
  - **May "solve" the difficulty of objectifying simulations**
    - **Many "false leads" followed during the first 10-15 years of OO M&S**
  - **Three key aspects – interfaces, interfaces, interfaces!**

The meaning of what JMASS implies

- **Distributed development, simulation integration and software reuse focus on two common themes**
    - **Decomposition of analysis problems into system and environment players, including model requirements, as illustrated by the rows on the matrix view of JMASS**
    - **Development, "ownership" and management of system and environment models, as illustrated by the columns on the matrix view of JMASS**

Essential to JMASS: *a stable, reusable, well-managed, interface-based set of system and environment models*

Matrix view of the JMASS system

Analysis Applications	Development Classes								
	Architecture		System Models	Env Models					
	Stds	GUIs	ECM Gun	RF	EO/IR	Acft	Radar	Msl	
Surface-to-air	X	X	X	X	X	X	X	X	X
Air-to-air	X	X	X	X	X	X	X	X	X
Sensor detection	X	X	X	X	X	X		X	
Air-to-surface	X	X	X	X	X	X	X	X	X
Surface-to-surface	X	X	X	X		X	X	X	X
Accreditation	← Verification and Validation →								

Relationship to JSIMS/JWARS

- **Joint Simulation System (JSIMS) & Joint Warfare Simulation (JWARS) - DoD M&S programs**
  - **JSIMS focused on training, JWARS on campaign analysis**
  - **More aggregate (than JMASS) system/environment models**
  - **Models aggregated from engagement (JMASS) results**
  - **Future may include direct use of JMASS, if meaningful**

Important to both: *a stable, well-managed, consistent, interface-based set of system and environment models*

JVB/JSB/JBE Connections

- **Joint Virtual Battlespace (JVB - the Army approach) & Joint Synthetic Battlespace (JSB - the Air Force term)** **& Joint Battlespace Environment (JBE - the JFC entry?)**
  - **Synthetic (simulated) arena of weapon systems interacting with each other and natural/man-made physical environment**
  - **Goal is to "immerse" warfighter in this simulated battle arena**
  - **Focus on System Under Test or Training (SUT), with other systems and physical environment represented appropriately**

Essential to both (all three?): *a stable, well-managed, consistent, interface-based set of system and environment models*

Has anyone addressed this?

- **Mr. Jim O'Bryon, former Deputy Director for Live Fire Test in the OSD/DOT&E office, has suggested in many fora over many years that a (collection of) consortium (ia) of subject matter experts might be the best way to manage M&S resources.**

- **Mr. O'Bryon's exact words were:**

  "Program Managers would initially describe their .. M&S requirements to a consortium which would then .. make the decisions as to which M&S tools best suit the PM's needs and [subsequently] .. upgrade extant models where available and originate M&S only when absolutely necessary."

Composability is Easy, Right...?!

- **Involves some pretty heady (and old) notions...**
  - Components "plug and play" into simulations
  - These components come "right off the shelf..."
  - All possible if the interface definitions are "done right..."

- **But is this really possible/practical/promising...?**
  - "Plug and play" has been elusive – even for Uncle Bill
  - Precious little thought on how the "shelf" gets stocked
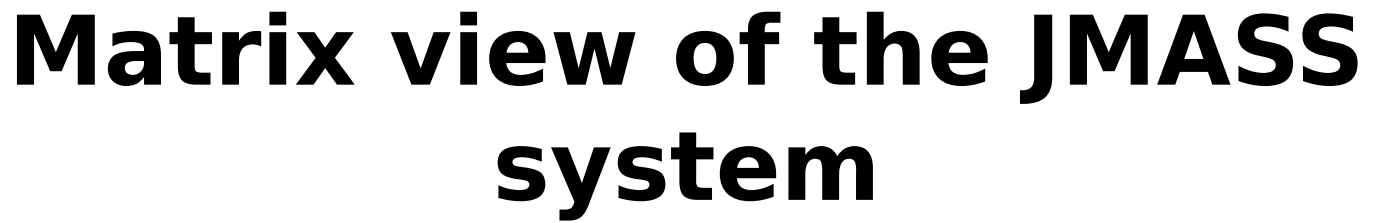 - Doing the interfaces "right" may call for circumspection and introspection more than implementation, for now...

Can the JMASS experience shed some light on this...?

Implications of JMASS paradigm

- **JMASS is (supports/needs) distributed development**
  - Threat models from DIA, blue models from SPOs, etc.
  - Orthogonal view gives user and developer perspectives

- **JMASS is (promotes/defines) simulation integration**
  - Simulation integration begins with problem decomposition
  - Application functionality + player list = model requirements

- **JMASS is (enables/benefits from) software reuse**
  - Software reuse in M&S can/does occur at all levels
    - Debate rages over optimum level of software reuse
  - JMASS reuse currently focused at the player level

Analysis Applications	Development Classes								
	Architecture		System Models		Env Models				
	Stds	GUIs	ECM	Gun	RF	EO/IR	Acft	Radar	Msl
Surface-to-air	X	X	X	X	X	X	X	X	X
Air-to-air	X	X	X	X	X	X	X	X	X
Sensor detection	X	X	X	X	X	X		X	
Air-to-surface	X	X	X	X	X	X	X	X	X
Surface-to-surface	X	X	X	X		X	X	X	X
Accreditation	←——— Verification and Validation ———→								

JMASS is distributed development

- **Assignment and acceptance of "ownership" for the model classes is essential for JMASS to work**
  - **Without assignment, development will never begin**
  - **Without acceptance, development will never complete**
  - **Without both, development at first stagnates and eventually fractionates into irrelevance**
- **Notion of "ownership" also key to effective reuse**
  - **Very dependent on informed oversight of what exists to know what can be considered as reuse candidates**
- **Distributed development does introduce the need for a separate simulation integration activity**

JMASS is simulation integration

- **Consider an analogy with LEGOs & K'NEX**
  - Toys based on connectable, interface-based piece-parts
  - Modern day Lincoln Logs, Tinker Toys, Erector Sets
- **Reusability of these toys aimed at very low level**
  - Focused on basic, simple (atomic) "building blocks"
  - Reusable components don't "look like" anything
- **LEGOs and K'NEX address a different reuse-type question than does JMASS**
  - LEGOs/K'NEX ask, "What can I make with these parts?"
  - JMASS simulation integration quite differently asks, "What parts (models) do I need to make this (simulation)?"

A matrix view of DoD M&S

SBA M&S domains	Developers							
	Architecture		**Env Models**					
	System Models							
	Stds	GUIs	RF	EO/IR	Acft	Ships	Tanks	
	Subs							
JWARS	X	X····	X	X	**X**	**X**	**X**	**X**	**X**
JSIMS	X	X	X	X	**X**	**X**	**X**	**X**	**X**
JIMM	X	X	X	X	X	x	x	x	X
JMASS	X	X	X	X	☐	☐	☐	☐	☐
JVB/JSB/JBE	X	X	X	X	X	X	X	X	X
Accreditation	←——— Verification and Validation ———→							

JMASS

Unique Application Interfaces

- Separate sim engine

- Inter-player interface visible/concise

- Multiple developers
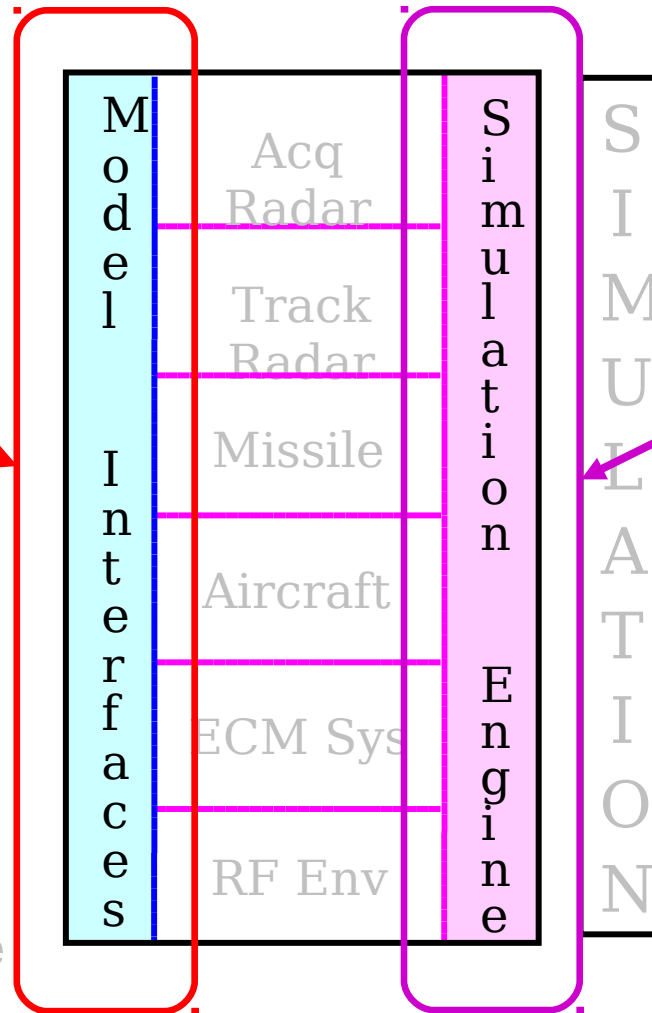
Legacy

Common Architecture Interfaces

- Do loop sim engine

- Inter-player interface hidden/convoluted

- Single

Model Interfaces

Acq Radar

Track Radar

Missile

Aircraft

ECM Sys

RF Env

Simulation Engine

SIMULATION

Thinking real big for a moment...

- **Different applications require different model detail**
  - **Focus of application determines what is important**
  - **JWARS aircraft likely more abstract than JMASS aircraft**
  - **JVB/JSB/JBE model detail likely to be variable**

- **Presumes existence of underlying model base**
  - **More abstract models depend on more detailed ones**
    - **You have to "know it" to know if/how/when you can abstract it**
  - **Consistency between abstraction levels absolutely essential for consistency between analyses supported by these different abstraction levels**

The DoD M&S Iceberg/Ice Cube…?
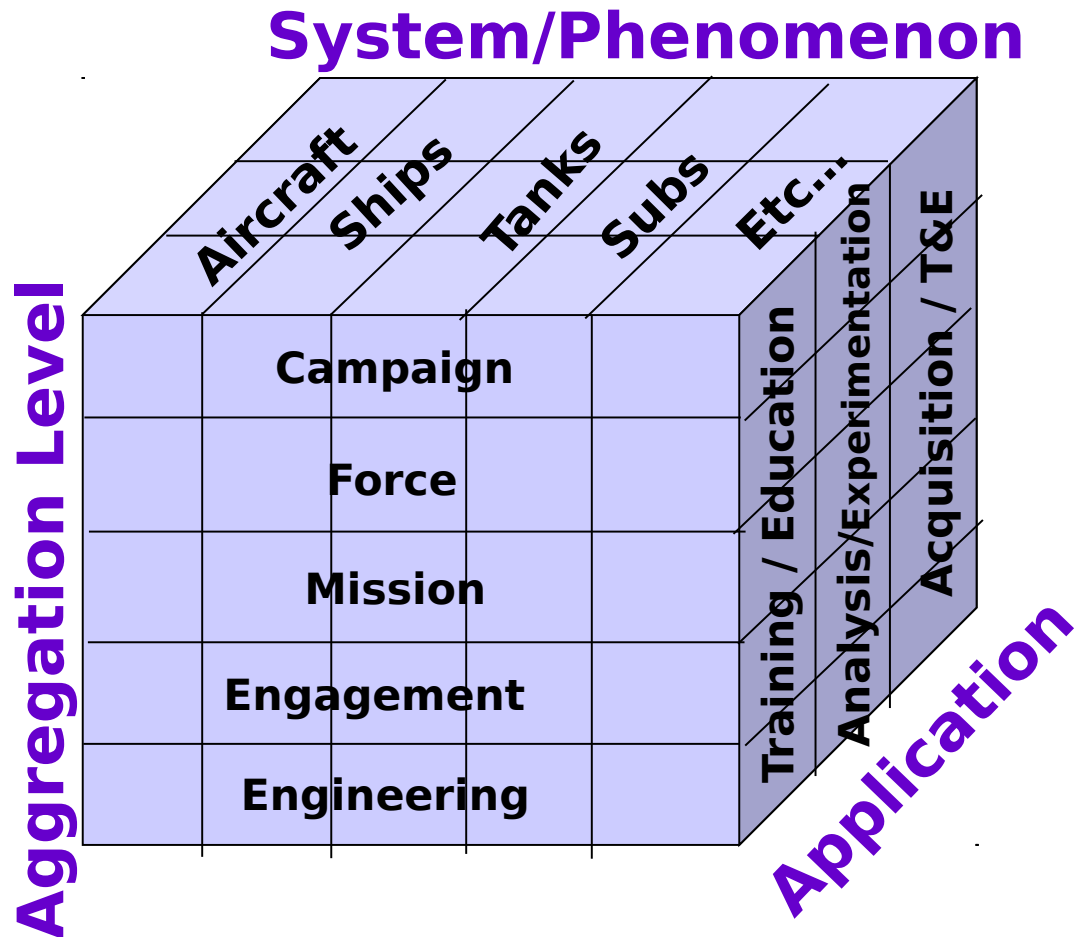
Looking closer at this Ice Cube

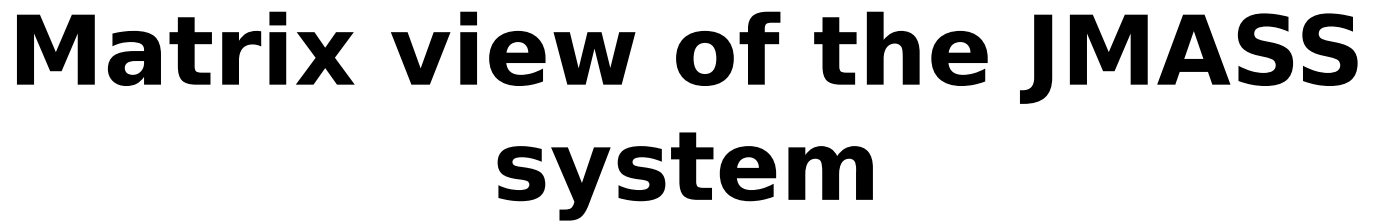| Model levels of abstraction	System Models		
	Aircraft Representation		
	Characteristics Motion …..	RF Signature	
Campaign	**Location changes**	**Single value RCS**	
Force	**3 DOF point mass**	**Waterline RCS**	
Mission	**5 DOF motion**	**Single table RCS**	
Engagement	**Full 6 DOF motion**	**Multiple table RCS**	
Engineering	**Dynamic drag/propulsion**	**N-point scatter RCS**	
Accreditation	← Verification and Validation →		

Coming back down to earth...

- **A lot of this model "iceberg" may already exist**
  - Legacy simulations hold a lot of the more abstract models
  - System developers have done many of the more detailed models in the process of developing their systems
  - Even so, organizing just what has already been done would probably eat up a sizeable share of the GNP!

- **A better approach might be to bite off a small chunk**
  - Start with JTCG/AS-related engagement-level models
 - For purposes of discussion, focus on the RF surface-to-air simulation arena, where legacy = ESAMS + RADGUNS

Matrix view of the JMASS system

Analysis Applications	Development Classes								
	Architecture — System Models			Env Models		Acft	Radar	Msl	
	Stds	GUIs		RF	EO/IR				
	ECM	Gun							
Surface-to-air	X	X	X	X	X	X	X	X	X
Air-to-air	X	X	X	X	X	X	X	X	X
Sensor detection	X	X	X	X	X	X		X	
Air-to-surface	X	X	X	X	X	X	X	X	X
Surface-to-surface	X	X	X	X		X	X	X	X
Accreditation	← Verification and Validation →								

Tip of the Ice Cube...?
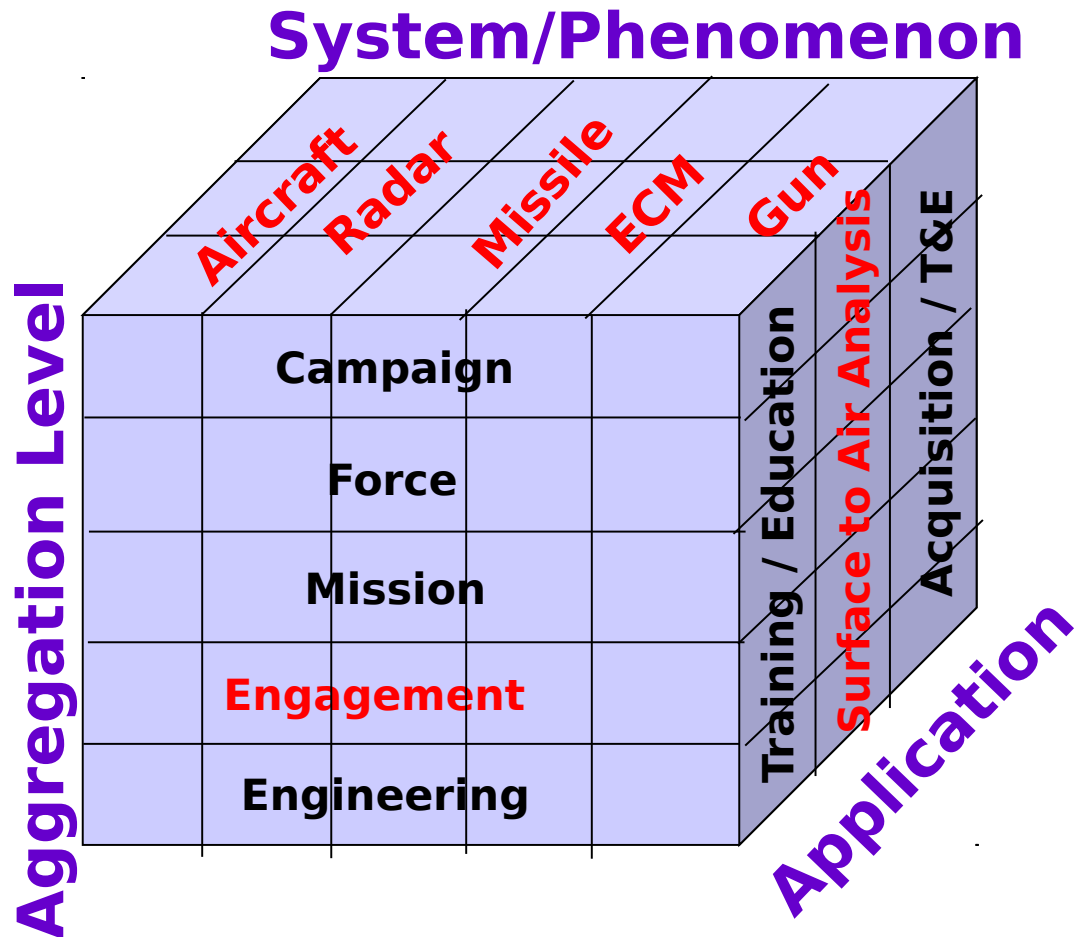
In summary...

- **JMASS has highlighted the DoD corporate need for a stable, consistent, well-managed, interface-based set of system and environment models.**

- **JMASS doesn't melt the DoD M&S "Ice Cube," but it does map out a visible tip, and offers many lessons learned and an existing, extensible infrastructure.**
    - **Composable simulations before composability was cool!**

- **There is a huge potential to share management of most pieces of the DoD M&S solution space.**
    - **Capturing existing "legacy" functionality**
    - **Leveraging existing resources ($$ and people)**

To contact JMASS Program Office

https://www.jmass.wpafb.af.mil

(937) 255-3969 (DSN 785-)

Bob Meyer (Navy Senior Engineer), ext. 3818
E-mail: Bob.Meyer@wpafb.af.mil

ASC/AAJ, Building 28

2145 Monahan Way, Room 131

WPAFB OH 45433-7017